classrooms

for the future must include such testing.)

In addition to his work at the Center, Dr. Ramage spends time at the nearby Westinghouse Research Laboratories, in the Instructional Technology Department. He is attempting to utilize research carried on there in setting up computer projects at the Center.

This type of university-industry cooperation is indicative of the interest industry is showing in educational developments. The Pitt LRDC program is financed by a grant from the U.S. Office of Education, but much of its support also comes from industry.

Pitt's LRDC was one of the first two of nine such educational research centers around the country financed by the U.S. Office of Education. Founded in 1964, it now has a staff of over sixty specialists in psychology, education, social science, and also industry.

Each staff member has a prime research concern, ranging from studies of response latencies and computer simulation of learning processes to the effect errors have on learning, and experimental designs of hardware.

The dedication of the LRDC staff is impressive. Each member is a specialist in his own right. Each is vitally concerned about education. There seems to be no hurry to "get something on the market" and no innovation is tried for innovation's sake.

Director Glaser feels that learning research centers such as Pitt's should substantially avoid the dangers of premature conclusions about the effectiveness of computer-based instruction. At Pittsburgh they are testing and evaluating extensively before they subject classrooms of children to the methods, materials, and apparatus being developed.

Teachers themselves must also become more scientific, demanding research reports on innovative processes and materials before "diving in" with new instructional modes.

The Pittsburgh LRDC staff is continually working to refine existing laboratory hardware and also to develop new devices. One such item is a ferrite manipulative board which can detect the shape and location of an object placed on its surface. An obvious area for its use is geometry.

Programmers at Pitt are mainly undergraduates. Some work full time; others half time. It is hoped that teachers will eventually be included, adding a measure of classroom experience to this facet of research.

The Center's future? Dr. Glaser believes that individualized instruction, the computer, and instruction based on psychologically tested methods will keynote future education. All of these are a part of studies at Pitt's LRDC. The Center's plans have two future trends in mind—first, the development of an educational technology that can provide for teachers tools and procedures based on scientifically conducted research, and second, the increasing involvement of engineers, behavioral scientists, and subject-matter specialists or scholars.

NEXT MONTH: Evanston, Illinois, tries computer report cards.

Miss Sponberg welcomes questions about CAI. Although she cannot answer them personally, they will assist in planning future articles. She also invites reports from readers concerning computer use in schools.

Evanston tried...

Computer report cards

SAM MIKAELIAN
and
RONALD B. THOMPSON

Could the computer be used to create a concise, meaningful pupil-progress report at no greater cost than present methods and with a saving of teacher-clerical time? Last spring Sam Mikaelian, then principal of College Hill School, a K-6 school in Evanston, Illinois School District 65, decided to find out. We asked Mr. Mikaelian, who now directs pupil services in Wilmette, to report on his experience. Coauthor Ronald B. Thompson is Coordinator of Research and Data Processing in Evanston. RAS

When College Hill teachers began planning for computerized report cards, a very practical problem confronted them—they had no computer and no money had been allotted for one in the annual budget.

A local business, The General Finance Corporation, solved both problems by offering free data-processing facilities. This meant unlimited time on their IBM 360 computer and the availability of their staff people as consultants.

Now the real work began—that of devising a new type of pupil report. The report in use, while comprehensive, was time-consuming to prepare, and because of teacher fatigue and statement monotony, lacked details. It included forty-six classifications of growth in knowledge and skills, plus seventeen classifications of growth in habits and attitudes. Performance and effort in each academic area were marked *excellent, satisfactory,* or *unsatisfactory*, and space adjustment to each academic area was provided for additional teacher comments. This reporting style made it difficult to analyze student and class marks, and the relationship of marks and teacher comments to other data.

College Hill teachers first considered the teacher comments used on past progress reports such as, *shows understanding of concepts and an interest in topics; does not comprehend and interpret what he reads;* and so on. They prepared a frequency table of eighty-eight statements (positive and negative) describing pupil achievement and behavior in grades one through six. These statements were revised into forty-four concise comments.

IBM cards, prepunched with the pupil's ID number and name, were prepared, with each teacher receiving one set of cards per child (one card for each area of evaluation). Using a graphite pencil, the teacher marked predetermined numbers corresponding to his name, subject, mark for subject (in grades 5 and 6 only), and pertinent comments. Although data for the computer was recorded on the IBM cards by code numbers, the print out would give in full the teacher's name, subject, mark (where applicable), and teacher comments.

A preliminary run of the progress reports was made so teachers could add or delete statements. The final report, sent out in April, was printed in triplicate (one copy each for home, cumulative folder, and principal).

Since this progress report was experimental in form and format, a letter to parents, briefly explaining the "new look," accompanied each report.

Now a tally of teacher comments and their use frequency was prepared for each teacher, and for the entire school. Teacher comments averaged twenty-one per report—more than previously.

Teachers then reacted to questions concerning their ideas about future use of this tool. All felt the computerized reports were time-saving, more straightforward, and a help to those teachers who might be less articulate or those who worry about handwriting and misspelling. There was a greater consistency of data within the school; reports were more comprehensive than before.

The teachers did want more teacher comments for the average achiever, and separate sets of comments for grades 1-3 and for grades 4-6. Most teachers wished to reword or eliminate some of the comments. Primary teachers wanted more comments to mention outstanding effort; intermediate-grade ones wanted more for pupils who try hard, but produce little.

Parent-teacher conferences were held one week after the reports were sent home. After each conference, parents were given a questionnaire concerning the report. In general, they felt a conference was necessary to further explain the report. They said this report card was precise, and easy to read, but they wished it could be more personalized.

Our second attempt (in June) at computerized report cards was more sophisticated. Statements were revised. Format and form were improved, allowing spaces for the teacher's signature, which added a "personal touch" and showed he had seen the report.

A cost comparison indicated 2.6 cents per computerized report card as opposed to our present cost of 5.5 cents per card. One hour of computer rental time, valued at fifty dollars, was also used. Considering cost alone, one would have difficulty making a case for continuing our present report cards. And no attempt was made to monetarily equate teacher time saved, time which went into further individualization of instruction.

NEXT MONTH: Pupils program computers in Lakewood, Ohio.

Miss Sponberg welcomes questions about CAI. Although she cannot answer them personally, they will assist in planning future articles. She also invites reports from readers concerning computer use in schools.

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COLLEGE HILL PUPIL PROGRESS REPORT          JUNE, 1967

TO THE PARENTS OR GUARDIAN OF-              HALF DAYS PRESENT. .
                       5- 4                 HALF DAYS ABSENT . .
PROMOTED TO GRADE....                       TIMES TARDY. . . . .

HOMERCOM TEACHER...............................

MRS. J. MONTGOMERY    READING               GRADE B
READS WELL ORALLY WITH EXPRESSION
UNDERSTANDS AND INTERPRETS WHAT IS READ FOR INFORMATION AND PLEASUR
SHOWS LITTLE OR NO INTEREST IN INDEPENDENT READING
APPEARS TO HURRY THROUGH WORK

MR. F. BEYER          PHYS EDUCATION        GRADE NONE
DISPLAYS INITIATIVE, IS RESOURCEFUL AND RESPONSIBLE
IS DOING WELL

MRS. M. MERRILL       DRAMA                 GRADE NONE
LISTENS ATTENTIVELY TO INSTRUCTIONS AND FOLLOWS PLANS AND DIRECTION
WORKS TO BEST OF ABILITY

MRS. J. MONTGOMERY    SOCIAL GROWTH         GRADE NONE
DISPLAYS INITIATIVE, IS RESOURCEFUL AND RESPONSIBLE
IS WORKING TOWARD GOOD CITIZENSHIP
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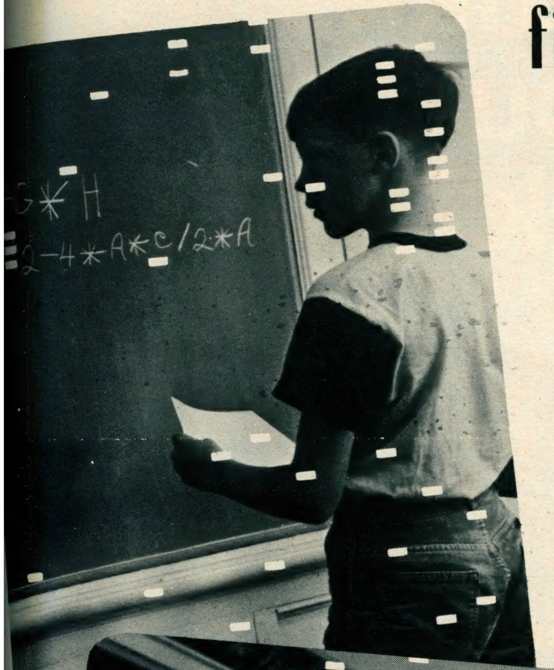
PROGRESS REPORTS for College Hill pupils appear on 8½" x 11" lined paper. This portion shows a variety of teacher comments in several academic areas.



ABOVE: Classroom instruction prior to using the computer included working complicated mathematical formulas.
BELOW: Pupil uses light bulbs representing a computer data card to register her answer to a question.

fifth and sixth graders Program a Computer

SUE ROUNDS

For the past three years, schools in Lakewood, Ohio, have sponsored summer enrichment programs for superior students in math, science, and the humanities. As part of last summer's math program, twenty-two fifth and sixth graders investigated computers under the direction of teacher Sue Rounds. Here is how these surburban Cleveland youngsters used the computer to practice knowledge gained in class. RAS

COMPUTERS were used in our elementary summer math classes primarily to acquaint children with this area as a possible vocation. We also wanted pupils to understand the limitations and capabilities of computers.

Students in the program had IQ's of 120 or more and composite arithmetic scores of one or more years above grade level on the Iowa Every Pupil Tests, and were recommended by their teacher and principal. Also in the program were pupils recognized as overachievers in math. These children did not have 120 IQ's, but were recommended by the teacher and principal solely on the basis of math potential, math achievement, and outstanding interest and effort.

At first, the children seemed to think computers were almost magical. So we established initially the idea that a computer can do only what it is told to do.

Three weeks (two hours each day) were spent in the program. We began by studying the binary system with which the computer works internally. This study also provided a foundation for the detailed, either/or instructions that must be given to the machine.

The next step was to learn the language of the General Electric Company's GE-265 computer which we would be using. For example, * means times, / means division, and SQR3 means $\sqrt{3}$. We practiced writing equations in computer language, as $x = \frac{-B + \sqrt{B^2 - 4AC}}{2A}$ to x = (—B + SQRB ↑ 2 — (4 * A * C)) / (2 * A).

Through this kind of exercise, pupils easily learned the logic in the equations, although there were many mathematical concepts in them that were new. For example, the children had not worked with square roots before, but it was easy to teach this concept when the computer could perform all of the difficult operations. Pupils understood the concept and left the drudgery to the machine.

Next we began writing programs for the computer. A GE technician spent one class session with us, explaining computer commands such as READ, INPUT, FOR, and NEXT, and under what circumstances each is used. The class learned that there are several approaches to programming a given problem, all of which will arrive at the same solution. Another speaker talked to the class about the future (and present) uses of computers.

Pupils were now taken to the downtown Cleveland General Electric Computer Center where they had access to the GE-265 through two terminals (teletypewriters tied in to the computer). These terminals could be used simultaneously with any number of outside terminals because of "time-sharing," a system allowing many people to use the computer at the same time to do a variety of operations independent of and unknown to one another. Each child had at least two opportunities to put a program into the computer and have a successful experience with the printout.

Although the group last summer were superior students, computers could also be used with pupils who are weak in mathematics, for computer logic is valuable in understanding mathematics. A programmer need not be able to square numbers or to find square roots or even to add or subtract. But he must be able to analyze a problem and present it in a logical order to the computer, which then performs the routine, sometimes boring, and often time-consuming operations. The computer is a tool for today!

NEXT MONTH: Project PLAN in Quincy, Massachusetts.

Miss Sponberg welcomes questions about CAI. Although she cannot answer them personally, they will assist in planning future articles. She also invites reports from readers concerning computer use in schools.

RUTH ANN SPONBERG
Senior Editor, The INSTRUCTOR

Teacher-written TLU's

Teacher Learning Units are unique to Project PLAN

OUR staff thinks of this Project PLAN as a computer-*managed* program . . . it is different from other projects because the teacher who implements it in the school also assists in its development," says David Johnston, principal of Adams Elementary School in Quincy, Massachusetts.

Mr. Johnston's statement pinpoints two important concepts of Project PLAN (Program for Learning in Accordance with Needs), a system designed to improve pupil achievement by using a computer to store and evaluate data on pupil progress. The computer also recommends the type of learning unit to meet an individual's needs. PLAN, developed by American Institute for Research in Palo Alto, California, is funded mainly by Westinghouse Learning Corporation.

The program, operating for levels one and five at the nongraded Adams School, is based on sets of educational objectives concerned with the types of behavior a pupil should be able to demonstrate now and later in life. To help meet these objectives, groups of learning activities called Teaching Learning Units (TLU's) have been created for reading, mathematics, language arts, science, and social studies. These activities are geared to the many abilities and styles of learning found in a regular classroom.

The computer terminal at Adams School relays information concerning each pupil's achievement in the five areas to the main computer located in Palo Alto. Here the information is stored, evaluated, and used to determine the pupil's next study "course."

Each TLU includes independent activities plus experiences for working with a partner or in a group, or with a teacher and group. Field trips and audiovisual experiences are often suggested. A TLU also allows for individual teacher-pupil conferences.

To complete a TLU, a pupil uses a variety of materials, such as books, records, study sheets (illustrated below), tapes, kits, and transparencies. Thus a well equipped media center for the school is a necessity.

Independent work and individual progress are emphasized on the TLU's, each of which usually takes about two weeks to complete. (A child works at his own rate of speed.) Self-correcting items written into the TLU helps a child evaluate his own progress.

Each TLU is followed by a test which checks what the child has accomplished, reviews material already covered, and pretests to predict and prescribe the pupil's next step. Testing at level one is done in the TLU guide, with a teacher aide transferring the child's answers to a special performance test card for later transmission of data to the Palo Alto computer. At level five, pupils put answers on the cards.

If a child does well on a test, the computer, which "knows" his special skills and interests, achievement record, and learning ability and style, then recommends three new TLU's. Final selection of the TLU to be used is determined jointly by student and teacher. If the child does not do well on the test and needs further practice in that area, the teacher works with him individually or in a group with other children needing similar help.

Two classes each in levels one and five are participating in Project PLAN this year. Next fall, levels two and six will be added, and the following year, three and four. Each class using PLAN is matched with a control class at the same level in another Quincy school, to compare results.

Two teachers from Adams School and teachers from fifteen other school districts around the country spent last summer in Palo Alto learning about Project PLAN. They also helped write the TLU's now used in the schools. Two other teachers are in Palo Alto this year.

Teachers using Project PLAN feel that pupils are now more independent, take more responsibility, and exhibit increased interest in school. Robert Pruitt, the superintendent of the Quincy Public Schools, says of Project PLAN, "This is an exciting thing . . . giving relevance and sequence to the learning process. We think this is the way education will go in coming years."

Miss Sponberg welcomes questions about CAI, and invites reports from readers concerning computer use in schools.

-255-1 CHOOSING DRAFT EDITION (11/67)

ITEM	USE	DO	SELF-CHECK	D
3. Objective 3488	Instructional Guide #2	3. Read IG #2, "Jobs' Lives Vary in Length", and follow all of its directions.	Can you write at least 1 benefit of planning ahead when you are thinking about jobs? Do you know 1 thing that kills jobs?	
4. Objectives 3489 3490	Instructional Guide #3	4. Read IG #3, "What to Think About Before Choosing a Job", and follow its directions.		
5. Objectives 3491 3492	Instructional Guide #4	5. Read IG #4, "Choosing" carefully, and follow its directions. Look at the pictures which illustrate this IG.	What are 4 major areas a person should think about when he is considering a job? You should be able to name 2 of your abilities, 2 interests, 2 personal qualities, and 2 values.	
6. Objectives 3489 3490	Instructional Guide #5	6. Read IG #5, "Choices Made by Someone Famous". Follow its directions carefully, and do all the steps.		
7. Objective 3488	Instructional Guide #6	7. Read IG #6, "Why Plan Tentatively?"	Write 1 benefit, different from the one you wrote above, of planning ahead about jobs. Can you say what "tentative" means? Do you know 1 reason you should have tentative plans?	

TLU assignment sheet (above) may refer students to study sheets (right) or to other materials. Each lesson has pupil self-checking devices.

INSTRUCTIONAL GUIDE #4 – CHOOSING

Now you can play a little game. Here is a list of things describing people. See if you can tell whether each is an ability, an interest, a personal quality, or a value. For each phrase, put an X in the column which described the phrase. For example, if you think "watches TV" is a value, you would put an X under value. When finished, turn to the answer sheet at the end of this IG to see how well you did.

	Ability	Interest	Personal Quality	Value
Watches TV				
Collects rocks				
Draws well,				
Is shy meeting people				
Can write poetry				
Reads about space travel				
Wants to be liked by others				
Laughs a lot				
Looks tall and thin				
Can sew				
Goes to science fiction movies				
Swims				
Is afraid to speak up in class				
Knows all about old cars				
Is handsome				
Wants to be rich				

Keeping up with Technology

RUTH ANN SPONBERG
Senior Editor, The INSTRUCTOR

This month we are reporting recent developments (projects and hardware) from the fast-paced field of educational technology. If your school is currently trying computer- or machine-assisted instruction, let me know! RAS

Logic for the gifted

Gifted elementary pupils at Grant School in Cupertino, California, are learning symbolic logic in their mathematics classes through a Stanford University CAI program. Sixteen pupils from Grant are involved in the first-year logic program, as are 182 other students elsewhere in California and Mississippi. Pupils use a teletypewriter connected with a computer on the Stanford campus. A normal year's work in symbolic logic (thirty lessons) has been programmed, but some pupils complete the sequence in less time.

PLATO goes remote

This fall, PLATO, computer-assisted instructional system developed at the University of Illinois, "goes remote," and an elementary school will house one of four new CAI classrooms in the Champaign, Illinois, area.

Geometry is one subject scheduled to be computer-taught to fifth and sixth graders. After being introduced to symmetry, pupils will use their newly acquired knowledge to explore the properties of triangles and quadrilaterals.

In the PLATO system, each pupil works in a small booth fitted with a television set and an electronic keyset with which he communicates with the computer.

Low-cost learning

A portable, 16-pound desk-top learning system, costing about $10 per child per year, has been introduced by Responsive Environment Corporation (REC), developers of the computer-based talking typewriter. This device, the Talking Page, can be operated by battery or electricity.

It has been designed to teach many subjects, including math, spelling, reading, skills, foreign languages, and English as a second language. Programs for the machine are being developed by REC in the United States, England, and Canada.

The audio part of the system (a special 7″ 45rpm record) is

synchronized with visual information carried on 8″ x 11″ printed sheets. Random access is provided to all material, both audio and visual, so pupils can repeat or skip material.

Sidewalk CAI

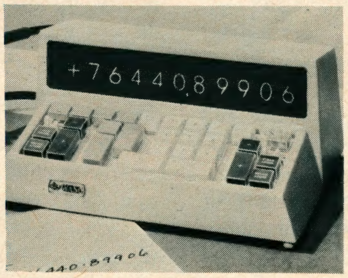
New York City's school system officially opened its new Computer Center in Manhattan this summer. Located on the ground floor of the Charles Pfizer Building, it enables pedestrians to see the city's CAI program in action. The Center has a central computer control room and an information center wtih two student terminals with which visitors can experiment. There is also a map showing the location of terminals in New York schools and a collection of large photos of children reacting to computerized learning. (About 6,000 children in 16 elementary schools in the Bronx, Brooklyn, and Manhattan receive computerized supplementary instruction in reading, spelling, and math on 200 terminals.)

Selected learning

A computer helps decide what two hundred children in two Pueblo Vista (New Mexico) elementary schools will learn. In the experiment, pupils are tested daily on a particular subject. Answers are fed into the computer, which selects a lesson on film for the class. The computer indicates which children will be bored by a particular film lesson (because they already are informed about the subject) and which pupils would gain from it. Pupils not viewing film have other assignments to complete.

Calculated math

Desk-top electronic calculators by Wang Laboratory are being used in elementary schools for modern math teaching. About the size of an ordinary desk telephone, the Wang Model 320 calculator allows students to perform all basic mathematical functions ($+$, $-$, $\times$, $\div$, $\frac{1}{x}$) by simply depressing the keys. Other keystroke functions provide for X^2, $\sqrt{X}$, $\text{LOGe}X$, and e^X. Lighted numerals 5/8″ high show results instantly. Special workbooks are



provided to help integrate equipment and techniques into any curriculum.

Telephone tutors

The Bell System's new Tele-Class service enables teachers to hold classes by phone with children who are physically unable to come to school or who need special attention for some other reason. The service is being tested in

New York City and Los Angeles with several hundred children who have long-term illnesses or other disabilities.

The teacher uses an automatic dialer on his desk to call students and start class sessions. Console buttons on the telephone allow him to talk to an entire class, to a group, or to an individual child. Pupils wear headsets so their hands are free for making notes, manipulating books, and so on.

Thinking while programming

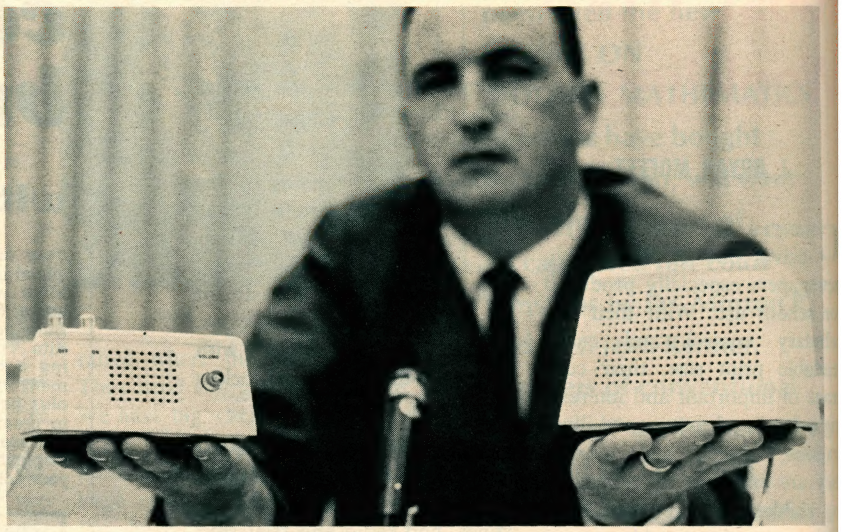
Nine-, ten-, and eleven-year-olds in the Los Alamitos School District near Los Angeles are learning logical thinking processes while learning to program a computer. An aerospace scientist-engineer is conducting the after-school lessons. He set out to show pupils how the logical processes of the mind work, but a by-product of his instruction is their learning how a computer works.

NEXT MONTH: Report on telelecture—Appalachia's in-service classroom.

Telelecture

Appalachia's in-service classroom of the air

SANDRA M. BROWN



BASIC telelecture equipment includes a transmitter (left above) and a receiving set (right). These can be rented for less than ten dollars per month.

The children of rural Appalachia go to school in tiny schools—more than one thousand of them are one-room. These children come from tiny hamlets and filter into school each morning in a dappled array of shiny faces, yesterday's clothes, and dusty, laceless shoes. The teacher's assignment may include students from six to sixteen, and the needs of these youngsters are great.

The teacher they meet is on his own—rarely is there anyone to call on for help. The rural supervisor is probably miles away. Curriculum specialists are almost nonexistent. Colleges and universities are scarce. Usually there is no library nearby.

High-caliber educational programs are needed to help break Appalachia's cycle of rural poverty and poor educational offering—programs which depend heavily upon teacher-training and daily communication. One example is a project called telelecture, *conducted last year by* EDUCATION, INC., *under the auspices of the Appalachia Educational Laboratory in Charleston, West Virginia.*

TELELECTURE is the shorthand for a process which makes meetings by voice possible. People in many different locations can talk together without leaving their own phones. It can bring together audiences of fifteen in five states or of five thousand in five different cities. It can tie together a national network of two hundred or it can be used for a simple conference of three.

The purpose of this particular project was to provide in-service instruction for fifteen teachers (sometimes several in a school) in five states simultaneously. It was to demonstrate that a single course could be conducted via telephone in widely separated locations.

Each Friday afternoon the telephone rang in the selected Appalachian schools—Powell and Knoxville, Tennessee; Coeburn, Big Stone Gap, and Sugar Grove, Virginia; Charleston, West Virginia; Marietta, Belpre, and Fayetteville, Ohio; and Barbourville, Kentucky. When all locations had been connected, the operator called the conference roll and the telephone workshop was under way.

The in-service course leader had previously met each of the people at the ends of the lines. She had talked with them face to face and knew a considerable amount about each one. She corresponded with them weekly and often commented on their letters during the telelecture. There was probably more communication between these teachers and their instructor than in a typical college course.

Attached to each local telephone was a small speaker which broadcast the call so that all in the room could hear. Also attached was a key device which enabled the teachers in each center to talk with the instructor and with teachers in any of the other centers. The result? An exciting in-service classroom of the air.

Teachers in the project were Head Start instructors who were helping to introduce into their school systems new language arts material (designed to teach language skills and beginning reading via programmed instruction). Normally it might have taken from five to ten years to muster the experience and training staff necessary to install this advanced curriculum in these schools. The medium of telelecture accomplished the job in less than six weeks, and the training the teachers received was far more intensive than that which usually accompanies new curriculum programs.

Of course there were problems. Most were technical, and the result of both the poverty and the isolation of much of Appalachia. For example, the telephone company serving one small town of southern Ohio was a three-person company—father, mother, and son. The office was their living room and the equipment minimal. The speaker in their installation was a battery-powered antique which went awry from time to time. During one conference, the line went dead, and the conference operator had to dial all numbers again to reestablish the circuit.

But despite the difficulties, reaction to the telelecture project was enthusiastic. There was a climate of excitement during the conferences. The idea of sharing suggestions and comments across the multistate network stimulated teaching efforts through the week.

The idea is now mushrooming across the country in a giant telecommunication project. A national network of connections is being arranged for in-service training in reading and language arts. Regional centers are being established to test different types of telecommunication available. Some teachers who participate will receive in-service training in their homes. Others will dial into special call-collect tape decks which will broadcast taped instructional lessons at specified intervals during the year.

As the idea spreads, teachers in both rural and urban areas can look forward to a national educational network of telephone systems through which ideas and in-service help can freely flow.

NEXT MONTH: Informal geometry via the University of Illinois' PLATO

Miss Sponberg, coordinator of this feature, invites other reports from teachers and administrators concerning machine- and computer-assisted instruction in schools.

Geometry via PLATO

J. RICHARD DENNIS

A recent geometry project at the Computer-based Education Research Laboratory (CERL) at the University of Illinois in Champaign involved a computer-assisted instructional system called PLATO. This geometry program can operate without the computer for presentation, but a CAI version is being tried this year with fifth and sixth graders in Champaign.

Our guest author is Dr. J. Richard Dennis, who developed the initial geometry program. He is now serving as Resident Consultant for the University of Illinois Committee on School Mathematics at Hawaii's Department of Education in Honolulu.

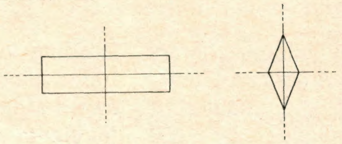
How is a PLATO geometry lesson conducted? Each student is seated in a small booth with a television set and an electronic keyset. He communicates with the computer by pushing keys on the keyset. Some keys type alphanumeric characters. Others have special control functions for moving the student through lessons. Still others are used to seek information, such as definitions, from the computer.

An unusual feature, but one essential to a geometry project, is the answering of questions by drawing pictures, with students using the keys of the keyset to construct the pictorial response. The computer is expected to judge and respond to the pictures as readily and as specifically as to verbal response items.

As an example, consider this exercise:

Draw a quadrilateral with just two lines of symmetry.

The question has two possible answers . . . the student could draw either a rectangle or a rhombus.



In a traditional setting, when the pupil gives one of these answers, a teacher would be likely to do two things—first, point out the features which characterize the given answer, and second, ask for another solution to the exercise. The PLATO system can do these same things where more than one solution is possible. The system can be instructed to note the first response, but to tell the student to look for another. Such features are difficult to achieve in text programmed material.

The computer acted as a teacher's assistant in presenting these geometry lessons. The initial program introduced principles of symmetry, and guided students in using these ideas to discover and explore the side-diagonal-angle properties of various types of triangles and quadrilaterals. Pupils were frequently asked to conduct tracing experiments to draw pictures. Observations from the tracing experiments were used to help answer questions about the figures they traced or drew.

The project was set up into seven sequences or lessons, with all seven controlled by the computer at one time. This feature virtually eliminated problems usually encountered because of pupil absences and the individual rates at which pupils can proceed. The PLATO computer continually collected data on each child's progress, so, for example, when a student returned from an absence the computer consulted these records and started the child at the spot where he ended his previous session. If the absence was an extended one, only a few minutes of the teacher's time were required to change the records so that the child could be given some review work before beginning a new lesson.

CLASSROOM teacher discusses tracing of geometric figure after pupil completes a computer lesson.

PLATO was programmed and the subject matter organized in such a way that the computer also assumed virtually all of the routine presentation (those items common to most of the children) and individual evaluation. Thus the teacher's attention could be directed entirely toward individuals—helping with specific problems not common to the majority of the group, or engaging in additional discussion and questioning of a child to pursue interesting sidelights of routine material presented during the computer lessons.

PLATO would be designated as a CAI system with multiple-lesson capability. In such a system a student who finishes a lesson never has to wait for slower students. Instead, he may choose to go on to the next lesson or to review previous ones.

I believe that computer-assisted instruction incorporates all of the desirable features of programmed instruction and eliminates many negative ones. Course material for CAI is written in units or frames (as is programmed instruction material), but it is possible in CAI to connect these units of instructional material in any way desired. It is also possible for the computer to respond immediately to specific conditions created by the student responses. Programmed instruction has neither of these capabilities. Certainly, if used appropriately, CAI can be another powerful method of communicating knowledge to students.

IN JANUARY: A teacher in New York City tells how CAI has affected his classroom instruction and planning, and his personal educational philosophy.

Miss Sponberg, coordinator of this feature, invites other reports from teachers and administrators concerning machine- and computer-assisted instruction in schools.

CAI/MAI

Computers in NYC Schools

. . . from a teacher's viewpoint

MICHAEL S. IMPORT

Third-grade teacher Michael Import, P.S. 284, Brooklyn, New York, tells what happened when he first became involved in computer-assisted instruction and how he helped pupils prepare for this kind of learning experience.

I BEGAN participation in the New York City CAI Project by taking a 10-hour training course to discover fundamentals of the system. Here I learned how to register students, how to preview the lessons pupils would take, ways to teach them to use the terminals, and how to evaluate the daily status reports printed by the computer.

With just twelve terminals in our school, classes had to be divided into at least two groups, with each having about fifteen minutes in the terminal room. What would I do with one group while the other was at the terminals? I devised a schedule allowing for more individual work with pupils. Three days a week are used for individualized reading lessons, spelling activities, or workbook exercises. Two days I teach handwriting (first to one group, then to another).

In our project, CAI is used primarily as a drill-and-practice device in mathematics, so perhaps my greatest problem was adapting teaching so that I was presenting concepts the computer would be reviewing or drilling *before* any child reached that concept at the terminal. I had to regularly preview the concepts to be presented by the computer so I could teach all new ideas well in advance.

How did I help my pupils get ready for computer instruction? One quick trip to the terminal room motivated pupils to *want* to learn all they could about using the stations. Back in the classroom, each child was given a duplicated sheet on which was printed a diagram of the keyboard he would be using. He was also assigned a code number to be recorded on this "keyboard."

To learn how to "speak" to the computer, pupils went through the motions as if their paper keyboard diagram was real. They "pressed" the start button and waited for a typed response. I played the role of the computer, and answered with, "Please type your number." We continued in this way until all of the steps required for "signing on" had been completed.

The next day they again went to the terminal room where they took turns sitting at the stations and reviewing the procedure they had learned. They then ran through a practice math lesson, using their duplicated keyboards to respond to a drill placed on the chalkboard. When the children finally used the terminals for an actual lesson, few errors were made—even the first day!

We also set up a classroom computer corner where pupils displayed magazine pictures of automated teaching devices, and copies of local newspapers containing articles and pictures describing our new system. Enlarged sample lessons were available so children could practice.

My pupils have readily adjusted to the simple format in which the computer material is presented and have demonstrated increased facility with and retention of mathematical concepts. Because each child is operating at his individual level, each is experiencing success. Mathematical ability is increasing, yet I am relieved of preparing and checking volumes of drill materials. Mathematics drill and review have become challenging and exciting!

IN FEBRUARY: Sixth graders in Plattsburgh, New York, write tests to be programmed onto computer.

Miss Sponberg, coordinator of this feature, invites other reports from teachers and administrators concerning machine- and computer-assisted instruction in schools.

CAI/MAI

Pupil-made Computer Tests

CHERYL PHILLIPS and EUGENE HILL

During the spring of 1968, several Plattsburgh, New York, sixth graders used a computer terminal to write tests which were then put into the computer so classmates could take them. Supervising this activity were Dr. Eugene Hill, then on the faculty of the State University College of Arts and Sciences at Plattsburgh, and Mrs. Cheryl Phillips, a computer programmer assigned to the University's Educational Research and Demonstration Center (ERDC). *A report of the activity follows.* RAS

The experimental "open curriculum" program has been operating for just over one year at Plattsburgh. In this program, methods and materials for the disciplines are used as the primary objects of pupil attention—the student (nursery on up) learns how inquiry is carried on in various areas of school.

Little formal teaching is done, and much time is spent in independent study. The teacher is a guide and consultant rather than a lecturer and director. Pupils spend much of the school day gathering data for reports from a variety of sources—books and other materials usually found in the classroom, school library, and audiovisual center; and the professional staff (school nurse-teacher, school physician, librarian, college staff members, classroom teachers, and college students in the "open curriculum" program who attend classes in the ERDC).

Reports can be oral, written, recorded on audio (or video) tape, or a combination of these methods. They are usually supplemented by pictures, drawings, and models.

In this type of environment, a group of sixth graders expressed an interest in using the computer for testing. They had given a report about the human nervous system. Elaborate drawings, made with the aid of an opaque projector, showed parts of the human brain, parts of nerve cells, the central nervous system, and a cross section of the spinal cord. These were displayed before and after the oral presentation. (The report was also written.)

After the report, members of the group were introduced to the programmer, who helped them put their self-written test on the computer. The test, one of recall-identification, provided a list of terms to be matched with descriptions of the function of parts of the brain or characteristics of the nervous system.

The results? Disastrous! No one (including the teacher) scored well. Even members of the test-making group missed items. It was apparent that more teacher guidance was needed in writing test questions.

A major difficulty in writing questions for a computerized test is that of delimiting the possible choices for correct responses. For example, if the child is to type the correct answer, how many variations of the spelling will be acceptable? If only the correct spelling is to be accepted, then the test becomes one of spelling and typing accuracy on the terminal keyboard, with knowledge of content becoming almost secondary. Thus, the decision to use multiple-choice questions.

There was some problem about the amount of time allowed each child taking the test. A computer can be programmed to permit an individual to continue taking the test on the same question until he makes a correct response, but the choice (Continued on page 164)

IN MARCH: Pupil testing in California's Hueneme School District is aided by a high-speed scoring machine.

Miss Sponberg, coordinator of this feature, invites other reports from teachers and administrators concerning machine- and computer-assisted instruction in schools.

High-speed scoring aids testing program

INNOVATION and experimentation are the backbone of the educational program of the Hueneme School District, Port Hueneme, California. One project, begun this school year, is the use of automatic, high-speed test scoring to improve teacher-made objective tests.

Key to the new project is a computerized test scorer, the Automata 450 (Automata Corporation), which can score tests at a rate of thirty every four minutes.

The machine also marks the edge of each student's test card for every wrong answer, enabling the teacher to immediately determine which questions were missed by most of the class. Totals for the number of right and wrong answers are printed on each student's test card, and class totals for each category are recorded on the tabulator.

Dr. Earl W. Eckert, Assistant Superintendent of Education for the district, believes that teachers are improving instruction and testing procedures by using the machine. "Whenever a majority of the children miss test items, it signals the teacher either that he did not adequately cover the material or that the test questions were poorly structured. With the instant feedback . . . the instructor can reteach the material while it is still fresh in students' minds.

"Teachers can test before they teach. Because of the rapid scoring results, teachers can diagnose the needs of their pupils and make immediate changes in their instructional plans to efficiently and effectively focus on the items of instruction that need the most attention. Correspondingly, they can eliminate unnecessary instruction on subjects that have already been adequately covered . . . teachers are able to provide instruction geared to the needs of the children."

One school involved in this experiment is the Richard Bard Elementary School. The principal, Bill Orluske, says, "We use the Automata 450 quite extensively, particularly for our weekly science and history tests. Since California has adopted a statewide text series for these subjects, we give our children the tests at the end of each chapter. The students

(Continued on page 154)

IN APRIL: Survey of "what's new" in CAI/MAI projects

Miss Sponberg, coordinator of this feature, invites other reports from teachers and administrators concerning machine and computer-assisted instruction in schools.

AUTOMATED EDUCATIO[N] CONTINUES EXPANSION

RUTH ANN SPONBERG
Senior Editor, The INSTRUCTOR

School districts, assisted by government and corporation funds, continue to experiment with the variety of teacher help that is available through machine- and computer-assisted instruction. Whatever the long-range future of CAI/MAI, there is no doubt that instructional devices, such as we have described in this series, have added to educators' knowledge of what "turns on" children in the learning environment. This month, instead of an in-depth look at a project, we will briefly describe five experiments which are currently attempting to provide knowledge about what happens when child and machine meet.

Dial-A-Drill, an experimental computer-to-home mathematics drill in New York City, involves some 2,450 elementary school pupils. Each pupil's home has a modified 12-button Touch-Tone telephone connected to the existing phone. At a prearranged time, attendants at the computer center telephone students and then switch the calls to the computer through special Data-Phone data sets. Drills, each five minutes long, are given three times a week. The program operates daily (except Sunday) from 2 p.m. to 10 p.m.

The program is being sponsored by the New York City Board of Education and the New York State Urban Education program, with the cooperation of the New York Telephone Company.

En-route instruction while pupils ride buses to and from school is becoming more common in rural areas. One example is a classroom-on-wheels project for students of Pennsylvania's Line Mountain School District. Each bus has five tape recorders (operated by the bus power system), each of which plays a 15-minute program. Students listen through a set of earphones and can select tapes (most of which deal social studies and the fine to which they want to listen.

Maladjusted children ages 12 are playing games with linked to a computer at Ge State College in Atlanta. part of an experiment in therapy in which young choose between aggressive (guns, boxing gloves, sold and so on) and constructive (such as a baseball game or coln Logs). The computer m tors activities through sensor tached to the toys or to dra in which they are kept. The spent in play with either kin toys is also recorded.

About 100 junior-high stud in Waltham, Massachusetts, developing typing skills at own rates by using the Ty Trainer developed by Sylv Electric Products. Each stu console, with a keyboard sin to a standard electric typewr is connected to a computer w is programmed to record the pil's responses and then let know how he is doing by me of a panel of colored lights. far, Waltham researchers say students seem to master the board more quickly than conventional instruction.

Poor spellers who need extra may profit most from CAI struction, since the pressure keep up with peers is lesser At least this is an initial find in a project in which the co puter helps teach spelling to sixth-grade Pennsylvanians. Center for Cooperative Resea with Schools at The Pennsylva State University coordinated 15-week test during which e student spent from four to n hours at computer terminals.

Miss Sponberg, coordinator of this ture, invites reports from teachers administrators concerning machine- computer-assisted instruction.

YOU and CAI

How is educatio
Where do

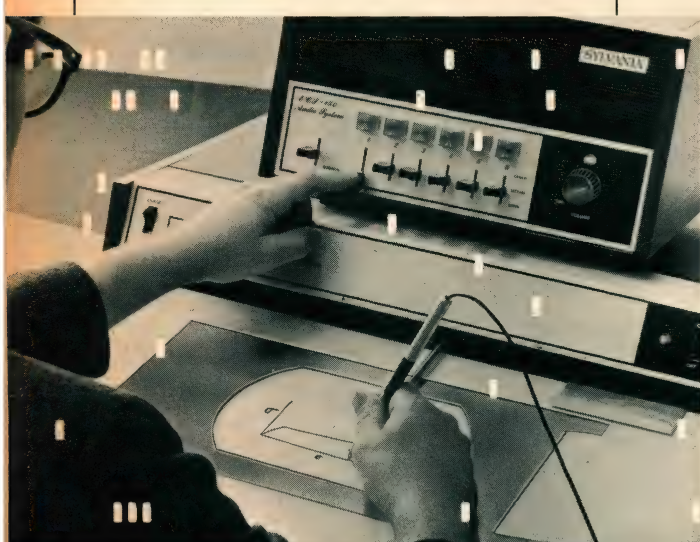
RUTH ANN SPONBERG
Senior Editor, The INSTRUCTOR

EDP, CAI, CAL, PLANIT, hardware, software. . . . Many industrialists and some educators seem to believe that computer-assisted instruction (CAI) with its special jargon is only a year or two away.

Teachers are concerned, and rightly so, about this revolution in educational technology. *Is* this the biggest thing since books? You have been asking questions about it. In a series of articles this year, *The Instructor* will offer straightforward answers.

TALKING TYPEWRITER Officially known as the Edison Responsive Environment, it involves the child in learning to read first letters and words, then sentences. The teacher is free to concentrate on trouble spots or enrichment.

COMPUTER Except in experimental projects, elementary children are learning about computers such as this one from General Electric but are not actually using them.



BLACKBOARD-BY-WIRE This system by General Telephone and Electronics allows the teacher to transmit handwriting and explanatory drawings to a TV screen in a distant classroom. When a light flashes on his console, he can push a button and answer individual questions.

TOUCH-SENSITIVE DISPLAY Any visu subject matter can be presented in a desi learning sequence when the child mak the correct responses. This touch-sensit screen was developed by Westinghouse.

chnology going to affect YOU the teacher?

omputer Assisted Instruction stand today?

Will your job as a teacher change because of computers?

Yes and no. Computers will accentuate a trend already underway—assisting children in individual creative endeavors and development of critical thinking.

Computers can free you to do this more effectively. They can take over much drill work that you do to help children acquire basic skills. You now put in hours of planning to design good individualized experiences. Computers can provide individually designed lessons.

Will computer-assisted instruction be a reality in the average classroom within the next two or three years?

It is coming, but it is not that close. Most experts predict it will be from 10 to 20 years because of several deterrents.

First, computer technicians have not completely solved problems of scheduling, space, and even the manipulation of equipment by children.

There is the economic factor. Limited school budgets now crowd out many exploratory programs involving computer technology. Most are funded by government or foundation grants, or by industry.

The programs are complicated to prepare and make available. They involve great effort now, but as we become more knowledgeable in this field, the situation is expected to ease.

What learnings are currently being programmed for computers?

Skills and concepts for drill-and-practice sessions in reading, math, spelling, and foreign languages are now receiving the most attention in research projects. As development and testing continue, tutorial programs in these and other areas will also increase.

Are some schools not connected with research centers using computers now?

Present school use of computers is largely in the area of educational data processing (EDP), such as class and bus scheduling, handling pupil personnel data, and general administration and accounting procedures. Teachers are using these information retrieval systems for such information as test performance, pupil progress, and guidance reports, for more effective planning of individual and group lessons.

Computers also "call up" media for teachers, such as films, filmstrips, books, and paintings. The computer memorizes the available materials or even lessons for many subjects or units of study. You push a button to find out what can be obtained, and then you select those which you can best utilize in your classroom. Next month we will discuss this system in more detail.

Similar computer assistance will probably be in use in your school long before you begin to use it directly with pupils.

Is any elementary school totally equipped now for computer learning?

No, and only a handful of complete *classrooms* are currently involved in experimental programs.

How can we be sure that learnings pupils need will be processed into computer programs?

Primarily through three ways. Prepared programs, with built-in selectivity, will be offered by educational companies.

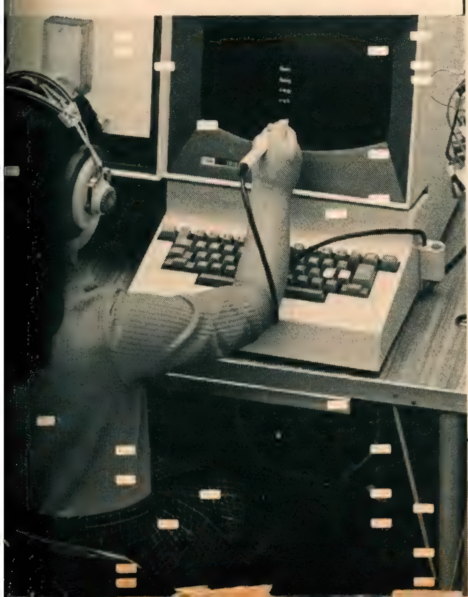
Or, you can outline your own lesson plan. Programmers (preferably educators, too) will set up the program from that outline.

You may become the programmer . . . a later article will describe how researchers are writing "computer languages," such as PLANIT, which will interpret for the computer a lesson which you first type out in plain English.

NEXT MONTH: How a teacher in Portland, Oregon, selects science lessons with the help of a computer programmed as a Teacher's Automated Guide.

Miss Sponberg welcomes questions about CAI. Although she cannot answer them personally, they will assist in planning future articles. She also invites reports from teachers and administrators concerning computer use in schools.

CHING COMPUTER At the IBM con- the child listens to a voice and then es by touching the screen with a light- Several wrong answers or no response es the computer to signal the teacher.



TEST SCORER The teacher marks correct answers (up to 50) on her Teacher Program Card. At the push of a button, the Automata, a test-scoring machine, marks each student card with the number of right answers and the number of wrong answers. Up to 450 cards can be scored in an hour.

Portland's computer conversation between...

TAG and the Teacher

NORMAN K. HAMILTON

This month's guest author, Norman K. Hamilton, describes how a computer helps a Portland, Oregon, teacher select science experiences geared to learning levels of her individual pupils. In effect, the Rice Elementary School project lets the teacher "curriculum shop" for suitable instructional materials.

"The intent of this research is to develop a way in which some of the personal abilities of a teacher, such as accurate and extensive memory, are amplified by the computer . . ." says Dr. Hamilton, assistant superintendent of the Portland Public Schools. The implication for all teachers? Help with lesson planning is on the way! *RAS*

LAST spring Genevieve Mattoon, a teacher at Charles A. Rice Elementary School, Portland, Oregon, "talked" with a computer about science experiences for her second-grade class. The conversation took place with Miss Mattoon sitting at a computer terminal, consisting of a cathode ray tube (resembling a television screen), a keyboard, and a teleprinter. How did the dialogue go?

Miss Mattoon typed the signal word HELP on the terminal keyboard. This immediately activated the Honeywell 120 computer located several miles away. The question DO YOU WANT TO INPUT DATA? appeared on the tube.

Miss Mattoon typed her answer—NO. The computer immediately signaled DO YOU WANT TO RETRIEVE DATA?

The teacher's answer—YES.

Thus began the friendship between Miss Mattoon and a computer programmed as a Teacher's Automated Guide (TAG). Developed by the Portland Public Schools with funds from the Louis W. and Maud Hill Family Foundation, TAG is an effort to harness the computer's power to help teachers individualize instruction by putting large quantities of teaching suggestions literally at their fingertips. (It also stores, for later retrieval, records on all students.)

Lesson selection Miss Mattoon had several alternatives in selecting experiences. Stored in the computer were abstracts of a lesson program, *Science—A Process Approach,* worked out by the American Association for the Advancement of Science (AAAS), plus other lessons designed locally or taken from other modern science programs (with permission of those controlling copyrights).

The material is sequential, so Miss Mattoon could have selected lessons by identification number or by level of difficulty (roughly equating grade level). Other alternatives—selection by content, selection by the process to be taught, or any combination of the above.

Miss Mattoon elected to scan all lessons dealing with the process of OBSERVING. Therefore, when the following words appeared on the screen, she typed the word OBSERVING in the space following PROCESS:

CYBEX NO.
PROCESS (OBSERVING)
LEVEL (
CONTENT (

She could have further limited her selection by inserting II, for her grade level, after LEVEL, or any of several subjects, such as PLANTS, ANIMALS, or COLOR, after CONTENT.

Twenty-four lessons on observing were stored in the computer. These ranged in levels of difficulty from LEVEL I to LEVEL XII, with two or three levels planned for each grade.

Miss Mattoon scanned the available lessons as they appeared on the screen:

PROCESS (OBSERVING)
LEVEL (I)
CONTENT (COLOR, IDENTIFY, HUE, MATCHING)

PROCESS (OBSERVING)
LEVEL (II)
CONTENT (TEMPERATURE, COLOR, COLOR-THERMOMETER, THERMOMETER, COLOR-CODE)

PROCESS (OBSERVING)
LEVEL (I)
CONTENT (SETS, NUMBERS, ONE-TO-ONE CORRESPONDENCE, EMPTY-SET, SHAPES)

PROCESS (OBSERVING)
LEVEL (II)
CONTENT (SETS, COLOR, SIZE, SHAPE)

PROCESS (OBSERVING)
LEVEL (II)
CONTENT (PERCEPTION, SOUND, NOISES)

PROCESS (OBSERVING)
LEVEL (II)
CONTENT (PERCEPTION, ODORS)

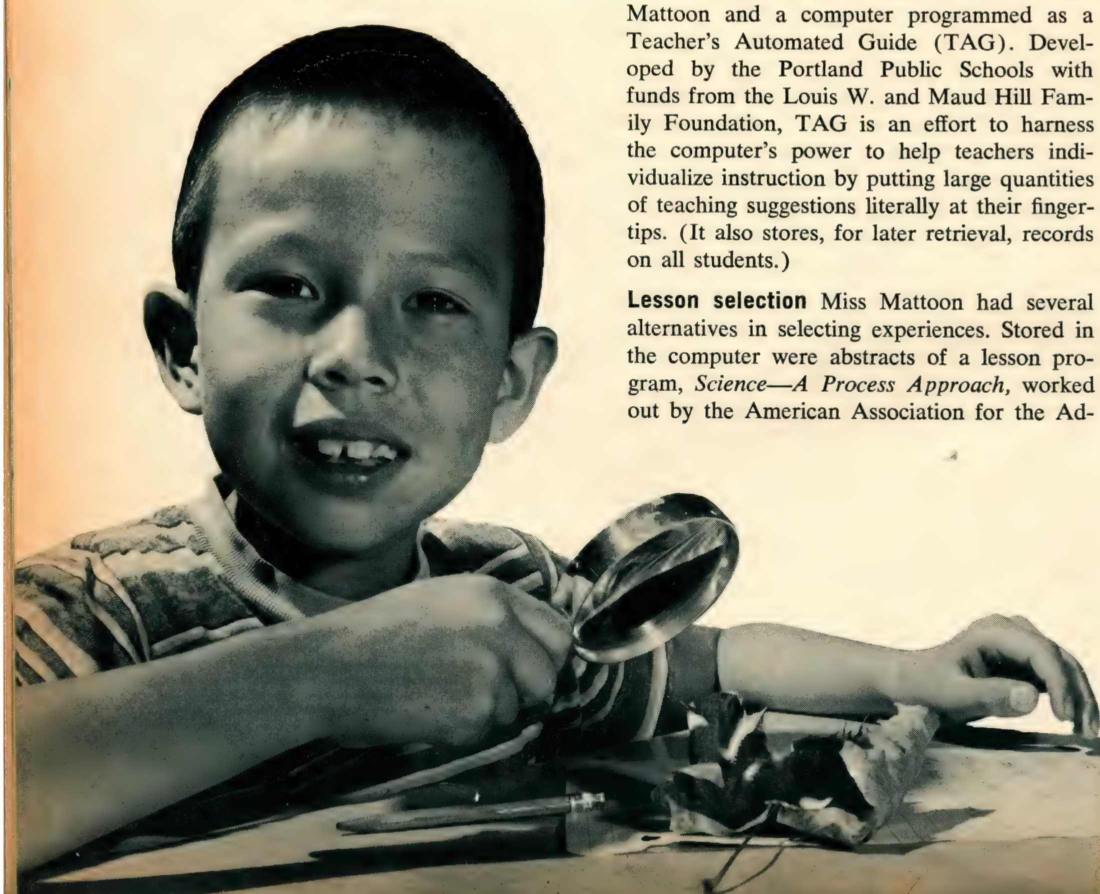
PROCESS (OBSERVING)
LEVEL (III)
CONTENT (ANIMAL, BEHAVIOR, PHYSICAL CHARACTERISTICS)

PROCESS (OBSERVING)
LEVEL (IV)
CONTENT (SENSES)

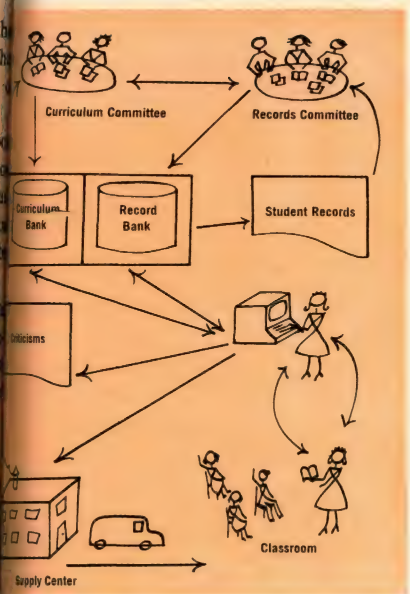
PROCESS (OBSERVING)
LEVEL (IV)
CONTENT (SOLID, LIQUID, MELTING, TEMPERATURE)

PROCESS (OBSERVING)
LEVEL (V)
CONTENT (MAGNETS, FORCES)

Miss Mattoon's class included the usual range of abilities found in a second grade. So she stopped the computer at LEVEL V because



INDIVIDUALIZED science lessons made available by the computer help Portland pupils sharpen their powers of observation.



ons of greater difficulty were obviously be-
d most of her pupils.

As the teaching "episodes" appeared before her, she noted code numbers so that later she could retrieve particular lessons which would be printed out for her by the teleprinter. Upon operating the teleprinter she received a written statement of the activities on LEVEL I, OBSERV- (COLOR, IDENTIFY, HUE, MATCHING). She received seven lessons in all on the AAAS central theme of OBSERVING, all dealing in some degree with sensory perception. Miss Mattoon also selected and retrieved a LEVEL II activity which would be pupils' learning one level above the first lesson. She "asked" for and received a printed abstract (printout) of that lesson:

```
TITLE (PERCEPTION OF ODOR)
INDEXES
PROCESS (OBSERVATION)
LEVEL (II)
CONTENT (PERCEPTION, ODORS)
RELATED ACTIVITIES
BEFORE (96001, 6002, 4005)
AFTER (4007, 4008)
ABSTRACT (PERCEPTION OF ODOR IS A WAY TO DISTINGISH SUB-
STANCES WITHOUT SEEING, HEARING, TASTING, OR FEELING.
THE CHEMIST'S TECHNIQUE FOR SMELLING IS DEMONSTRATED.
SUBSTANCES ARE CLASSIFIED BY ODOR. MATERIALS: CINNA-
MON, VANILLA, SALT, FLOUR, ALCOHOL, WHITE VINEGAR, PEP-
PERMINT EXTRACT, FOOD COLORING, PAPER BAGS, PEANUT BUT-
TER, ORANGE, ONION, TWO GLASS BOTTLES, AND CHOCOLATE
SQUARES)
```

Related services A related service built into the TAG system is that of student record-keeping. By typing the signal HELP, Miss Mattoon could have retrieved, for each pupil, stored records germane to his learning abilities. The Record Bank contains such data as teacher comments on work habits and interests, objective measures of ability and achievement, information from special education services, and information related to pupil achievement and specific instructional goals.

TAG's potential has not yet been reached. If the science experiment proves successful, the design can be extended to include other subjects of the curriculum.

As illustrated by diagram at the left, the TAG program is being planned by two committees, one on student records and one on curriculum. Curriculum materials are selected by a committee, indexed, and fed into the computer's Curriculum Bank. Student records are put in systematic order for storage in the computer's Record Bank. All of this data is available to teachers at Rice School.

The teacher may retrieve data about science lessons or pupil records. He may put data into the computer or criticize the curriculum materials received. Eventually, if all goes well, the teacher will be able to retrieve a list of needed supplies and materials required for his teaching plans, and then order the materials for 24-hour delivery. And all done by computer!

Why is Portland engaged in such an experimental program? Basically, to improve instruction, but also to help in the collective efforts to adapt the computer to educational use.

should be noted. Those that become obsolete must be corrected or rejected. Need for additional activities should be noted and supplied by the curriculum committee.

Before TAG For two years, Rice teachers prepared themselves for TAG. They worked with central committees in developing the program. There was intensive in-service education in the AAAS science program. They studied data processing and worked with technicians and computer experts to understand the computer and its potentials. There was general involvement in planning the scheme of objectives and general rationale of the system.

TAG's future Although the first computer program deals only with science, Portland teachers are now setting up programs in mathematics, social studies, and foreign languages.

This fall another unit is being installed in Portland's Wilcox Elementary School. By next spring, Andrew Jackson High School and its eight "feeder" schools will be supplied with sixteen to eighteen terminals. It is hoped that one or more display devices will eventually be installed in each district school.

MISS MATTOON sits at computer terminal to scan abstracts of individualized AAAS science lessons. Upon request, teleprinter at her right gives printed copy of a complete lesson.

TAG is based on several premises:

- *The teacher is best able to select learning experiences for children from a large collection of tested activities.*
- *Curriculum content must be self-renewing.* Information in the lessons must be current. Teaching guides must provide for constant correction, in both activities and content.
- *There must be constant feedback.* Teachers must be masters of the machine. Those lessons which teachers find most successful

NEXT MONTH: From Stanford, California, a report on how a teletype connected to a computer is used for drill-and-practice sessions in mathematics.

Miss Sponberg welcomes questions about CAI. Although she cannot answer them personally, they will assist in planning future articles. She also invites reports from teachers and administrators concerning computer use in schools.

Drill and practice by teletype

This is a report of a drill-and-practice program in mathematics and spelling. Although Stanford University's widely publicized Brentwood Project has somewhat overshadowed this CAI effort in Palo Alto, its significance is being felt in elementary schools in California and in other states, as far away as Kentucky.

In early spring of 1965, a commercially available teletype machine was installed in a book closet adjoining an elementary classroom in Grant School in California's Cupertino Union School District. The teletypewriter was connected by a private telephone line to a computer in Stanford University's Laboratory for Learning and Teaching.

For seven weeks, daily drills in mathematics were given via the teletype to forty-one fourth graders. Today, about 2300 first through sixth graders are using similar teletype machines in thirty schools across the country, including Breckenridge School at Morehead, Kentucky, almost 2000 miles away. The system is the same . . . the daily drill lessons are carried to the school by telephone lines from the Digital Computer Corporation's PDP-1 in Palo Alto.

Approximately 2900 lessons per grade level support the program. The number of problems within a lesson varies from about five to thirty (twenty is the average), depending on the type of material. Each drill is short, about five minutes in duration.

What happens when a child uses the teletypewriter for, say, a lesson in math? As he takes his turn, the machine prints out an introductory statement as PLEASE TYPE YOUR NAME AND NUMBER. The child replies by typing his full name. If he makes a mistake, the machine prints out a request for him to retype it. If he does this correctly, his first problem of the day is printed out. A place is left for him to respond. For example, $(5 \times 4) + 6 =$ ______. If he answers the first problem correctly, the second problem appears. If he does not, the machine types out NO, TRY AGAIN, and the first problem is repeated.

If he makes an error the second time, the machine will then type NO, THE ANSWER IS ______ and give the correct answer. The problem is then repeated again so the child can add the correct response himself. He and the machine then move on to the next question.

As a child works through each drill, his correct and incorrect answers, the amount of time spent in answering, the percentage of problems or answers correct to date, and the total amount of time he has spent with the program are recorded on the computer. This information can later be retrieved by his teacher.

An audio system can also be used with the teletype. Prerecorded messages may be sent through individual speakers to each student via a special system designed by the Westinghouse Corporation.

Instruction on the teletype is supplementary to the regular curriculum presented by the classroom teacher. The program is set up on five levels of difficulty for each grade level and for each concept in instruction. Pupils can be moved up or down the program from day to day, depending on the previous day's performance.

According to Max Jerman, research associate at Stanford's Institute for Mathematical Studies in the Social Sciences, which is directing the teletype project, this kind of personalized approach to instruction makes the teacher more aware of individualization and carries over into other teaching situations.

And, says Jerman, the children themselves are more de-

. . . from a computer 2000 miles away

THE CLASSROOM TEACHER often discusses errors on the teletype lessons with pupils. He may find that he needs to change his pattern of instruction to assist in problems that are causing general class difficulty.

RUTH ANN SPONBERG
Senior Editor, The INSTRUCTOR

manding. They are less content in group situations—they want something to happen to them personally . . . some action or change.

"Teachers involved in the project also become greater specialists in subject areas so they can check on the programming. They are learning to use the data they receive from the computer lessons in preparing future classroom experiences. They are becoming diagnosticians, able to take the computer information and use it to determine the best kind of classroom program for each individual child."

Staff members of the Stanford project feel sure that computer-assisted instruction can have much impact on skill mastery in math, reading, spelling, and the foreign languages because of the control of variables relevant to learning. Speed is important in these areas, they say. Timing and pacing of these activities is difficult under ordinary classroom conditions, but with the aid of a computer, it can be automatic.

Do students seem bored when the novelty of using the machine wears off? Seemingly not, says Jerman. The motion of the teletypewriter as it prints out the questions catches and holds pupil attention. The children must also continually read questions and react by typing answers.

Problems with the teletype system have been mainly system failures or delays in the Stanford laboratory itself. Telephone-line transmission problems are sometimes a cause of difficulties. Computer-component failures have occurred, and faulty programming or debugging (correction of errors in a program) have also caused a few delays.

What is the future of this California-based computer program? Many see it as expanding to include schools in every state. The Breckenridge program has Appalachian children benefiting from the same educational techniques as children in Oak Knoll School in Menlo Park, California, or Universal School in southern Mississippi at McComb.

Title III is lending financial support to the Kentucky installation. As the program spreads, it is felt that private organizations, and eventually individual school systems, will begin assistance in offering children across the country a highly specialized, advanced curriculum equal to the best to be found in urban and suburban centers anywhere.

NEXT MONTH: What happens when sixth graders play the computer-controlled "Sumerian Game"? A report from Westchester County, New York.

Miss Sponberg welcomes questions about CAI. Although she cannot answer them personally, they will assist in planning future articles. She also invites reports from teachers and administrators concerning computer use in schools.

ST PUPILS seem to master kly the simple operations reed to operate the teletypewritnd then give rapt attention to personalized sequence of ning material. Some schools all a single teletype in a closet ning the classroom. Others set e an area to handle several.

What it's like when children Play a Computer Game

IN THE computerized Sumerian Game, the student takes the role of a priest-ruler. Westchester has also experimented with games involving economic problems in Sierra Leone and the management of a toy store.

WILLIAM F. O'CONNOR

The Sumerian Game is a unique CAI experiment being conducted in Westchester, New York. Our guest reporter, William F. O'Connor, talks about it, and about the role of CAI in this age of teacher shortages and increased emphasis on individualized education. *RAS*

SUSAN, sitting before a typewriterlike computer terminal, has just watched a slide series and heard a taped description of the city-state of Lagash, Mesopotamia, in 3500 B.C.

The printout on the terminal now says: WE HAVE HARVESTED 5000 BUSHELS OF GRAIN TO TAKE CARE OF 500 PEOPLE. HOW MUCH OF THIS GRAIN SHOULD BE SET ASIDE FOR NEXT SEASON'S PLANTING, AND HOW MUCH WILL BE STORED IN THE WAREHOUSE? THE REMAINDER WILL BE GIVEN TO THE PEOPLE TO EAT. Susan, assuming the role of priest-ruler of this land, must now make a decision about this problem.

Susan is one of about fifty sixth graders who recently took part in an experiment conducted by a division of the Northern Westchester Board of Cooperative Educational Services (BOCES). It was part of a program begun in 1962 with the production of the Sumerian Game, partially described above. Originally a joint venture of the BOCES Center and IBM Corporation, its purpose was to investigate the computer's potential in light of our growing educational problems. Starting in 1963, the program was supplemented by two U.S. Office of Education grants.

The program's objectives? To test the applicability of computer-controlled games to individualized instruction and to test their learning effectiveness. How would these games stack up against conventional teaching in amount of learning and time invested by pupils?

The Sumerian Game was designed to teach some basic economic principles. After Susan had watched the slide show and heard the tape-recorded message mentioned earlier, she received instructions on how to play the game and was given her first problematic situation of how much grain to plant, save, and eat.

When a child priest-ruler makes his decision, he types his answer on the typewriterlike computer terminal, and the message is instantly sent to the computer. The computer responds with an analysis and rapidly sends back the results. Then, the child watches the terminal print out a "six months" progress report on his actions. He may find that he has saved too much grain and some has rotted or that he didn't save enough for planting and next year's production won't be enough. He is then asked to make similar decisions for the next six-month period, based on past mistakes and inventory, for which a new progress report is issued.

This computer game allows the pupil to go as fast or slow as he wishes throughout the game, as he competes only against the model. As the game develops, more complex problems are introduced, such as land acquisition, crafts, population, and trade. The student sets the pace, with the computer automatically introducing the proper level of information.

The Sumerian Game was followed in Westchester by one on economic problems in Sierra Leone and one in management of a toy store. They, too, place the child in a real-life role with real-life problems, and grow in complexity as the child develops skill and knowledge.

To measure the games' effectiveness, a small-scale experiment was conducted. Two groups, similar in intelligence and reading ability, were selected. The "experimental" group was brought periodically to the BOCES Center to play the computer games. The "control" group was taught the same subject matter in its home school. All were tested before and after the experiment. General behavior and other significant events were recorded for the experimental group, and each child was interviewed following the games.

The results? Except for two students with reading handicaps, the games were played without teacher intervention. Pupils were easily able to follow game rules and instructions as printed out by the terminal. All but one child reported that he had enjoyed the games and had maintained a high level of interest and enthusiasm. The experimental group showed significantly more gain than the control group from pretest to posttest in the Sumerian Game. The control group gained slightly in the Sierra Leone Game. The most significant result, however, was that the experimental group invested about one-half the time to make the same gains.

Computer games in their present form do not appear to be more effective than the teacher, but they do appear to teach as much in less time. Says Dr. Richard L. Wing, BOCES Coordinator of Curriculum Research, computer-based games ". . . seem to offer possibilities of partial solution to some of the perennial problems of mass education: inefficiency in teaching, curricular limitations, inadequate motivations of students, unreliable measurements of results and neglect of individual needs."

NEXT MONTH: What about machine-assisted instruction? Are MAI and CAI comparable in their results?

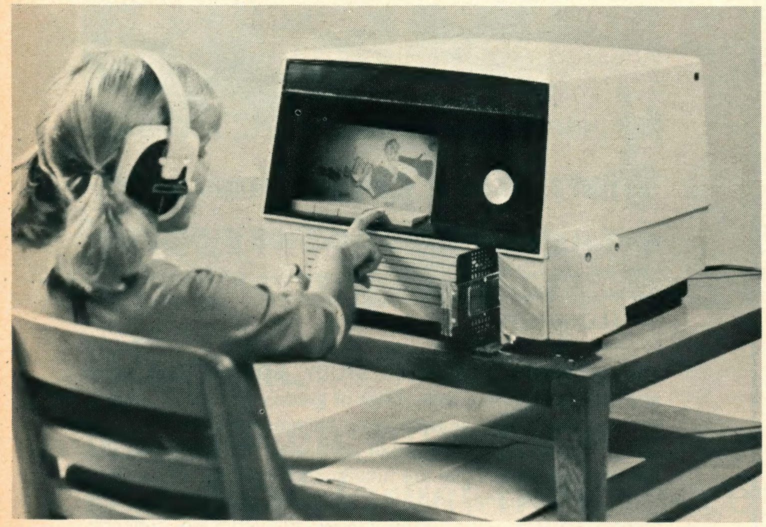
Miss Sponberg welcomes questions about CAI. Although she cannot answer them personally, they will assist in planning future articles. She also invites reports from readers concerning computer use in schools.

Machine-assisted instruction

competitor or concomitant?

Individualizing instruction is a major goal of elementary teachers and administrators. But the hang-up comes in discovering realistic ways to do this. In past months, this feature has discussed individualizing through computer instruction. Now, what about learning devices that are electronic but not computerized? Where do they fit into the individualization scheme, and what is their relationship to computers?

FIRST let us consider some identifying features of noncomputerized machine-assisted instruction (MAI). The equipment runs the gamut of size and sophistication. Some of the earliest were primarily tachistoscopic, used for drill and remedial work.



THE correct answer button must be pushed to advance a color filmstrip and recording in this portable electronic unit from Borg-Warner Corporation.

Today many of these machines can be adjusted to various speeds and used to emphasize sequential development in several areas.

Advances in both technology and programming have led to tutorial devices with multiple functions. They range from types that require a single stimulus response to those which utilize both audio and visual stimuli. The more expensive and complicated language laboratories also qualify as MAI.

Programs for these machines (sometimes spoken of as software) are on magnetic tape; paper sheets, rolls, or cards; slides; film; records; or combinations of two or three of these. They are commercially produced, teacher-prepared, or both.

Education and industry experts agree that much of the success of both CAI and MAI lies in the quality of the programs. However, adequate research is still lacking in such areas as the degree of needed motivation, the desirable size for the program, the proper sequence, and the amount of reinforcement. More specific determinators will show how to create good programs and how they are affected by other influences in the environment.

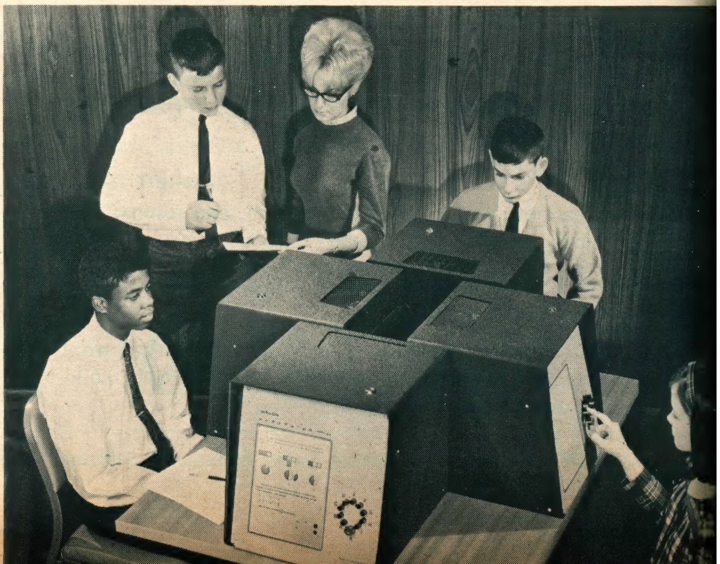
Immediate feedback is a feature of some electronic instructional aids. Branching (the process of directing a child to another item depending on his response to a previous item) also occurs on some machines, as it does with most computer systems. Error detection and counting equipment are generally not featured on these devices, although a few do have them. When they are not available, the teacher manually checks answers.

Largely because of budget restrictions, machine-assisted instruction was first used mainly as a remedial device or to challenge gifted youngsters through more advanced work. It also proved successful with children who have hearing, visual, and motor handicaps. Where verbal and discriminatory skills are lacking, and attention span is short, both CAI and MAI seem to help.

The influx of ESEA money is bringing large numbers of these MAI learning devices to schools. Now teachers are having the opportunity to see that MAI equipment can be effective in individualizing regular instructional programs—that it is an everyday tool to be used on a regular basis by every child in the class.

LINEAR-TYPE programs for the Craig Reader are designed for a range of subjects at all levels, and are contained on rigid plastic slide units.

BRANCHING is a feature of the AutoTutor, produced by The Welch Scientific Company. Students answer questions by selecting one of the response buttons.



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Teachers find that MAI and CAI can be used as early as kindergarten, but that they are not equally effective with all children. In addition, the equipment works best if it is interspersed with other types of learning activities.

Most of the MAI devices are free-standing and fairly small. They can be kept in a classroom and easily moved around as needed. Such flexibility would be impossible with present computer systems, but the computer can serve a much larger role.

When children of similar abilities use identical machines with identical programs, teachers have a valid basis for comparison of individual gains. They can also make somewhat accurate analyses of the individualized learning process, and subsequently explore adjunctive techniques for providing such instruction.

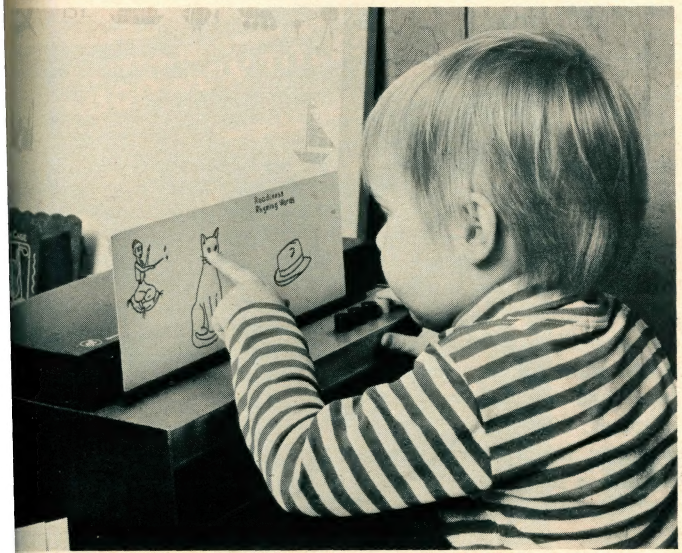
Cost of MAI is relatively low on a per-pupil basis. Most school systems are able to afford several pieces of this equipment and may have plans to buy more, while a computer system may not be on their budget horizon for many years. In the majority of states, machines can be purchased under Title I for use with disadvantaged children, or if for library installation, under Title II.

Is MAI a forerunner, a concomitant, or a competitor to computer-assisted instruction? It is certainly the first two. Teachers involved in MAI sharpen their skills in selecting commercial programs and in preparing programs themselves. They devise new uses and work out scheduling techniques. When and if computer instruction becomes a reality for them, they will have a ready-made background.

Both types of instruction serve specific classroom needs and their functions overlap. Even so, comparisons at this point are not meaningful. What is important at the classroom level is to use any available equipment as purposefully as possible. If the classroom teacher is eager to individualize, he will experiment and decide for himself how his equipment can best serve the needs of his group.

NEXT MONTH: An overview of computer research projects being conducted at the University of Pittsburgh.

Miss Sponberg welcomes questions about CAI. Although she cannot answer them personally, they will assist in planning future articles. She also invites reports from readers concerning computer use in schools.



UDIOVISUAL and kinesthetic exercises ombine in the Audio Flashcard system om Electronic Futures, Inc. Teachers use lank cards to develop their own programs.

University of Pittsburgh investigates Computer-based

RUTH ANN SPONBERG
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THE Learning Research and Development Center at the University of Pittsburgh is housed in the Mineral Industries Building, an old brick structure on Pitt's Oakland campus. This unimposing building seems like an inappropriate setting to be the center of the country's foremost research about learning and about modern educational technology. But here psychologists, computer experts, teachers, and social scientists are combining knowledge and know-how in an investigation of computer-based classrooms.

By its own definition the Center has as its goal "the strengthening of scientific foundations for improved educational practices." Behavioral scientists and educators are combining their efforts with engineers and subject-matter scholars to conduct studies of the learning process and to develop educational models. Through exploratory and theoretical research, innovative instructional systems are being designed and tested.

A visit to Pitt's Learning Research and Development Center (LRDC) leaves many impressions, especially the extensiveness of the array of equipment in its third-floor laboratory. The hardware ranges from a Digital Equipment Corporation PDP-7 computer and a Westinghouse random access audio-unit to a "touch sensitive" device that has a Kodak random access carousel slide projector.

But research at Pitt does not stop with the hardware. Creation of quality programs (software) for use with the machines is also claiming staff attention. Programs in spelling, timetelling, and number experiences are being developed at the elementary school level. There are efforts to devise a "computer" language which teachers may eventually use to program their own materials for the computer.

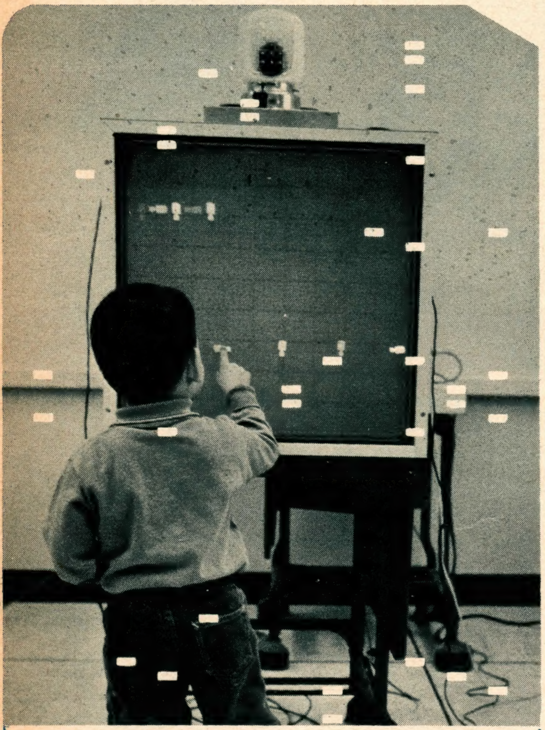
Psychologist Dr. Robert Glaser, a pioneer in the field of teaching machines and programmed instruction, is Director of the Center. Glaser is guiding LRDC activities in the direction of three major research concerns: first, to find out what happens when man comes in contact with a machine (interface); second, to develop a computer language for teacher use; and third, to inquire into basic instructional strategies, such as how to individualize instruction and in what areas.

For the classroom teacher, possibly the most interesting unit would be the electronic student station, which consists of a loudspeaker or a set of earphones, a keyboard similar to that of a typewriter, and a cathode ray tube (similar to a television screen) with an electronic pen that "writes" with a beam of light. (At times, a microphone is also added to the station.)

It is with this student station that basic research is going on concerning the learning and teaching processes. The results may acutely affect tomorrow's elementary classrooms and lead to instruction in a computer-based setting.

Dr. William Ramage is Director of the Computer-Assisted Instruction Project at the Center. Based on his experiences to date, he considers the computer to be an excellent control device for use in individualizing instruction. In contrast to present instructional schemes, the computer can detect errors, and control amount, rate, and difficulty of material presented to the learner. It also provides feedback on achievement at the time when it is the most helpful to the child—immediately—and most psychologists recognize that delay in evaluation lessens its effectiveness, especially with small children.

(To date, none of Pittsburgh's programs has yet been tried on a classroom basis. However, plans



TOUCH-SENSITIVE DEVICE Colored shapes are presented in a series on upper section of screen. Student picks out next shape from random group at bottom of screen. If he touches board at correct spot, success is indicated by a bell ringing and a large light on top going on.

EXPERIMENTAL STUDENT STATION Recorded voice heard through earphones gives child directions. "Typed" response appears on cathode ray tube above keyboard.